EQUILIBRIUM PRICING RELATIONSHIPS

"To avoid having all your eggs in the wrong basket at the wrong time, every investor should diversify" Sir John Templeton

Modern Portfolio Theory (MPT) goes back to a revolutionary academic paper published by Harry Markowitz in 1952 [Mar59]. The concepts were developed by other American financial theorists such as William Sharpe in the 1950s and 1960s [RCO98]. The thinking behind this theory is that security diversification reduces risk. Spreading investment across a range of assets has a risk reducing effect. In a diversified portfolio unexpected bad news concerning one company will be compensated to a certain extent by unexpected good news about another. Markowitz argued that investors would optimally hold a mean-variance efficient portfolio, that is, a portfolio with the highest expected return for a given level of variance [CLM97]. Investors can select the optimum risk-return trade-off for themselves, depending on the extent of personal risk aversion.

Markowitz (1959) laid the groundwork for the CAPM. Sharpe (1964) and Lintner (1965) built on Markowitz's work to develop an equilibrium single period asset pricing model. They showed that if investors have homogeneous expectations and optimally hold mean-variance efficient portfolio then, in the absence of market frictions, the portfolio of all invested wealth, or the market portfolio, will itself be a mean-variance efficient portfolio. The usual CAPM equation is a direct implication of the mean-variance efficiency of the market portfolio [CLM97]. With the assumption of the existence of lending and borrowing at a risk free rate of interest the expected return of asset i is given by the equation:

$$E[R_i]=R_f + \beta_{im}(E[R_m]-R_f) \qquad \beta_{im} = \frac{Cov[R_i, R_m]}{Var[R_m]}$$

Where R_m is the return on the market portfolio, and R_f is the return on the riskfree asset.

The CAPM implies that the relationship between expected return and β_i is linear, only β_i is necessary to explain differences in returns among securities, the expected return of an asset with a β of zero is r_f, and the expected return of an asset with a β of one is the same as the expected return on the market [Abh2000-4].

$$E(R_i) = \alpha_0 + \alpha_1 \beta_i$$

Early tests of the CAPM are conducted by Lintner (1965), Black, Jensen and Scholes (1972). Roll's (1977) critique for the inconsistency of the empirical test of the CAPM, is that the market portfolio used in these tests is not the "true" market portfolio. Roll's main point was that the only potentially testable hypothesis associated with the CAPM is that the true market

portfolio is a mean variance efficient market portfolio. All other hypotheses (like expected return and beta being linearly related) are redundant given this main hypothesis. The Bad News was that this Main Hypothesis could not be tested since the Market Portfolio (the portfolio of all the assets in the economy) could not be observed [Abh00-4]. The CAPM is widely used project valuation, the evaluation of portfolio managers, and in determining the cost of capital [Abh00-5].

In the absence of a risk-free asset, Black (1972) derived a more general version of the CAPM, known as the Black version of CAPM [CLM97].

The Arbitrage Pricing Theory (APT) was introduced in Ross (1976) as an alternative to the CAPM [CLM97]. The APT allows for multiple risk factors and does not require identification of the market portfolio. This theory assumes competitive, frictionless markets, and can be stated as follows:

Suppose we have N assets, the return on these assets is an is an (N×1) vector with

$R = (R_1\ R_2 \ldots R_N)^T$,

A is a (N×1) vector (the intercept of the factor model),

B is a (K×1) vector of factor sensitivities for asset i,

F is a (K×1) vector of common realizations,

and ε is an (N×1) disturbance term.

For the system of N asset the APT model is as follows:

$$\mathbf{R = a + Bf + \varepsilon}$$

Given this structure, Ross (1976) shows that the absence of arbitrage in large economies implies that

$$\mu \approx \iota\lambda_0 + B\lambda_k$$

where μ is the (N×1) expected return vector, λ_0 is the model zero- beta parameter and is equal to the riskfree return if such an asset exists, and $\boldsymbol{\lambda_K}$ is the (K×1) vector of risk premia.

In this model the market portfolio is one factor and additional factors are the state variables. The intuition for the additional factors is that these arise from investors demands to hedge uncertainty about future investment opportunities [Abh00-7].

FUND PERFORMANCE MANAGEMENT

A fund is a pool of money operated by a fund manager. There are many types of funds including: mutual funds, insurance funds, pension funds, or bank-pooled funds. The fund manager's job is to maximize the fund's returns at the least risk possible [NASD99]. The most common type of fund is the mutual fund which is an investment company that pools money from shareholders and invests in a diversified portfolio of securities [Inv98].

Trillions of dollars are invested in stocks world-wide by institutional portfolio managers. From a social perspective it is important to know whether these investors as a group add value to the portfolios they manage or whether they merely generate wasteful transaction costs through their active management. At the micro level it is important to know how to select a portfolio manager with the ability to add value to the portfolio he manages. Performance evaluation is a topic in financial economics that seeks to address both of these issues. In particular, it studies whether superior returns can be generated by active managers who are better able to collect and interpret information that help forecast securities returns. To evaluate whether a manager has generated superior returns we need to adjust his portfolio return for risk ([Gri95], [Abh00-6]). Two types of performance measurement can be conducted. The first involve the observation of the returns of the evaluated portfolio as well as the returns of a benchmark that consists of one or more portfolios along with a risk-free asset. The second type of performance measurement utilizes information about the composition of the evaluated portfolio but does not necessarily require a benchmark portfolio. Some performance measurement relies on the assumption of stationarity and normality of returns.

TRADING STRATEGIES

There are two basic orientations in trading strategies. A ***fundamental*** trader tries to predict what prices will do on the basis of factors that can be considered as affecting supply and demand. In the case of investment in commodities, the investor looks at future change in consumption patterns and the factors affecting the production of the commodity. In the case of currencies or financial futures, the investor monitors the change in political or economic policies. For stocks, the investor looks at the company's annual report, the quality of its management, and the factors affecting the changes in supply and demand for the services and goods required by and produced by the company. A ***technical*** trader looks for patterns in the trading data for the stock or commodity and tries to use them to predict the direction of future price changes. Typical criticism of fundamental trading would be: "if you can predict the changes in supply or demand that are going to occur, so can other traders. If they can predict

them, then the price probably already reflects these coming changes." Typical criticism of technical trading would be: "All your systems can do is tell you what happened in the past. They can't predict the future. History doesn't really repeat itself." The real difference between the two approaches is a philosophical one. The fundamental trader sees the behavior of the marketplace as the necessary result of supply and demand for the financial asset. Therefore prediction of price changes can best be done by correct analysis of factors influencing supply and demand. The technical trader sees his task as the prediction of trading behavior which is the cause of price movement. Accordingly, future behavior can be predicted by looking at past behavior and identifying patterns [Gol88]. Technical trading strategies [Gol88] include:

moving averages: this is the simplest and most commonly used technical system. It is simply a price following system. It averages the prices of the most recent five days. This is compared to the average calculated for the previous day. If the average has gone up, the prices has gone up and you might want to be long, and if the prices has gone down, the prices are tending down and you might want to be short.

double moving averages: this is similar to the moving averages except that two averages based on different numbers of days are used. When the average based on the smaller number of days rises or remains above the average based on larger number of days, it indicates that a price rise has begun or is accelerating. The reverse implication also holds true.

oscillator or momentum indicator: Instead of comparing yesterday's average with today's average, this methods compares yesterday's change in moving average with today's change in moving average.

on-balance volume: instead of relying only on price movement, this method considers also the volume of trading

stochastics: the word stochastic is generally used in reference to random series. Stochastic technical trading tries to follow price movement by eliminating irrelevancies.

Computer programming for technical trading involves reading in the data, implementing the technical trading strategy, and devising two versions for going short or going long.

FINANCIAL INSTRUMENTS

The pace of financial innovation has accelerated sharply since the late 1970s, due to the deregulation of the financial industry and the increased competition and volatility in the financial markets. In the beginning, there were four instruments: a bank deposit, a bill of exchange (banker's acceptance), a bond, and equity. However, today a large number of new

financial products have been introduced with the aim of transferring risk, enhancing liquidity, generating credit, and generating equity. Walmsley (1988) classifies financial innovation as product/process and aggressive/defensive. Process innovation involves change in the process of financial markets such as the introduction of new trading technologies. Aggressive innovation is the introduction of a new product or process in response to perceived demand. A defensive innovation is introduced in response to changed environments or transaction costs. The effect and risks of recent financial innovation are ballooning trading volume, increasing exposure of financial institutions to each other, and a growing complexity in defining monetary aggregates and formulating monetary policy.

Broadly speaking, a financial security is a legal contract that confers the right to receive future benefits. A financial security is usually traded in organised markets. Financial securities are classified [Kol96, Elt95, CLM97, BKM96] as direct investment or indirect investments. Direct investments are classified as cash product vs. derivative security. Cash market instruments are classified as money or capital market instrument. Money market securities are short-term debt (maturity less than 1 year) issued by governments or companies. Examples include: Treasury Bills (TBs), Repurchase Agreements (REPOs), Certificates of Deposit (CDs), bankers acceptances, commercial paper, and eurodollars. Capital market instruments are long term securities with maturities greater than 1 year. They can be debt ("Fixed Income") or Equity.

Fixed income debts promise a stream of future cashflows as fixed interest payments ("coupons") paid at fixed dates, and repayment of the principal. Fixed income securities are issued by governments and companies.

The classical bond bears a fixed rate of interest, and matures on a date fixed at the time of issue. The price of a bond is the present value of its future cash flow. A bond is considered to be a fixed income security. One of the important characteristics of fixed income securities is the yield curve, which is a plot of fixed-income instruments against their maturities. A yield curve holds a lot of information. It displays the market's current yields for different maturities, it also shows the implied forecasts that the market is making about future rates.

An equity is a company share that gives its holder an ownership in the assets and earnings of a corporation. A share has no maturity, nor does it have any fixed claim on the assets or earnings. Shares give their holder rights to dividend if declared. The theoretical value of a stock is the present value or discounted value of the future stream of dividends. The stock today should be priced at the present value of dividend stream. Some ratios are also important in the valuation of equities. These are:

Price-earnings ratio = market price of share / net earning per share

Dividend yield = dividend per share / market price of share

Payout ratio = dividend per share/ earnings per share

A derivative instrument has a value *derived* from the value of some underlying asset (equity, bonds, currencies, ...), such as futures, options, swaps, etc...

Options on financial instruments, notably on stocks, have been around for years, but until 1973 they were tailor made. It was possible to buy an option but not to trade it. Later on, exchange-traded options were introduced: the first was the Chicago Board Options Exchange (CBOE). Basically, an option is an agreement between two parties, giving the right to buy/sell an instrument (stock, bond, future contract, interest rate, or foreign currency) under certain conditions. There are two basic types of options: *puts* and *calls*. A call option gives the buyer the right to buy or "call away" a specified amount of the underlying security at a specified price, during a specified period. The price at which the instrument may be bought is the *exercise price* or the strike price. The last date on which the option may be exercised is the *expiration date*. The price paid for the option is called the *premium*. Depending on the underlying instrument, the mechanics of options trading vary from contract to contract. Option valuation is quite complex. The price of an option is determined by six factors: (1) the price of the underlying instrument; (2) the striking price of the option; (3) the time remaining until expiration of the option; (4) the volatility of the underlying instrument; (5) the current, risk free interest rate; (6) the dividend rate of the underlying stock or the interest rate of the underlying security. The most widely used way for valuing options works on a principle known as the riskless hedge. The Black-Scholes model, used for equity option valuation, uses riskless hedge. The assumption of riskless hedge valuation models are:

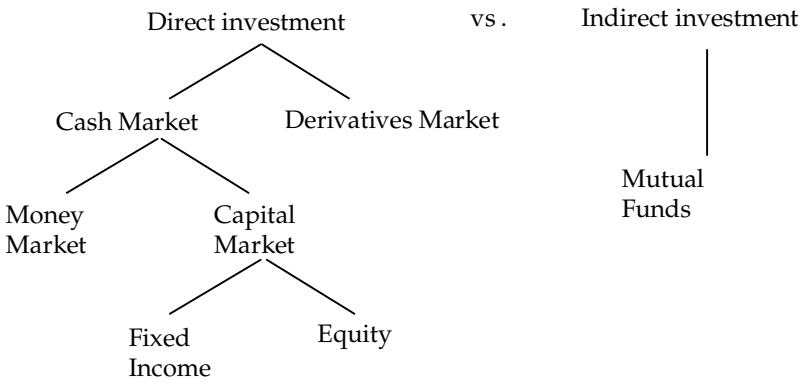
1) prices may change rapidly but cannot jump, and one can trade continuously in the market;
2) there is a risk free rate of interest for borrowing and lending from the current period until the expiration of the option;
3) transaction cost and taxes are ignored.

In the Black-Scholes formula the key assumption is that the price of the stock is a random variable in continuous time, and that the percentage change in its price has a normal distribution.

The above description of instruments covers direct investment. Indirect investment includes investment in Mutual Funds. These can be "open-end" funds (Unit Trusts), or "closed-end" funds (Investment Trusts). Mutual funds are funds operated by an investment company that

raise money from shareholders and invests it in stocks, bonds, options, commodities or money market securities. A closed-end fund has a limited numbers of shares outstanding. A closed end fund starts with a set number of shares that are traded on a stock exchange. Open end funds continually creates new shares on demand. Shareholders can redeem their shares at any time at the prevailing market price.

The following figure – based on Gruber (et al, 1995) - depicts the classification of financial instruments.



Classification of financial instruments